at point P5 and ends at point P6. Point P5 occurs later than point P1, and point P6 occurs later than point P2. The fall of the pulse begins at point P7 and ends at point P8.

The rise of a pulse in signal OUT3 begins at point P9 and ends at point P10. Point P9 occurs later than point P5, and point P10 occurs later than point P6. The fall of the pulse begins at point P11 and ends at point P12. Likewise, the rise of a pulse in signal OUT4 begins at point P13 and ends at point P14. Point P13 occurs later than point P9, and point P14 occurs later than point P10. The fall of the pulse begins at point P15 and ends at point P16.

The rise of a pulse in signal OUT5 begins at point P17 and ends at point P18. Point P17 occurs later than point P13, and point P18 occurs later than point P14. The fall of the pulse begins at point P19 and ends at point P20. Points P3, P7, P11, P15 and P19 all occur at the same time. Likewise, points P4, P8, P12, P16 and P20 all occur at the same time.

The signal resulting from a summation of OUT1, OUT2, OUT3, OUT4 and OUT5 has a rise that begins at point P21 and ends at point P22. Point P21 and point P1 occur at the same time. Likewise, point P22 and point P18 occur at the same time. Thus, the rise time in the summation signal is longer than the rise time of the input signals.

The summation signal has a fall that begins at point P23 and ends at point P24. Point P23 occurs at the same time as points P3, P7, P11, P15 and P19. Similarly, point P24 occurs at the same time as points P4, P8, P12, P16 and P20. Thus, the fall time of the summation signal is the same as the fall time for the input signals. As a result, the summation signal is an asymmetrical driver pulse in accordance with one embodiment of the invention.

Summing Amplifier

Figure 14 illustrates a summing amplifier with five inputs in accordance with one embodiment of the present invention. Other embodiments have another number of inputs. More inputs result in more flexibility in adjusting the output waveform. Fewer inputs result in a lower circuit complexity. The positive supply voltage, V_{cc}, couples to the anode of laser diode D1 and the collectors of transistor M6, transistor M7, transistor M8, transistor M9 and transistor M10. The cathode of D1 couples to the collectors of transistor M1, transistor M2, transistor M3, transistor M4 and transistor M5. The output current, I_{out}, is measured through laser diode D1.

OUT5+ couples to the base of transistor M5, and OUT4+ couples to the base of transistor M4. Similarly, OUT3+ couples to the base of transistor M3, and OUT2+ couples to the base of transistor M2. Likewise, OUT1+ couples to the base of transistor M1.

OUT1- couples to the base of transistor M6, and OUT2- couples to the base of transistor M7. Similarly, OUT3- couples to the base of transistor M8, and OUT4- couples to the base of transistor M9. Likewise, OUT5- couples to the base of transistor M10.

The negative supply voltage, V_{ee}, couples to current generator I_1, current generator I_2, current generator I_3, current generator I_4 and current generator I_5. Current generator I_1 couples to the emitters of transistors M1 and M6. Likewise, current generator I_2 couples to the emitters of transistors M2 and M7. Similarly, current generator I_3 couples to the emitters of transistors M3 and M8. Likewise, current generator I_4 couples to the emitters of transistors M4 and M9. Finally, current generator I_5 couples to the emitters of transistors M5 and M10. In one embodiment, the current generators produce equal values. In other embodiments, each

current generator is individually controllable, so the current generators may produce differing values.

Asymmetrical Driver Pulse

Figure 15 illustrates an asymmetric driver pulse in accordance with one embodiment of the present invention. One pulse 1500 is initiated at time –100 ps, and the current rises to the high level of 50 mA 1510 more slowly than the current falls to a low level of 20 mA 1520 when the pulse is terminated at time 20 ps. Thus, the pulse width is 120 ps. A second pulse 1530 is generated 100 ps out of phase with the first pulse. As a result of the difference in rise and fall times, the eye 1540 of the driver pulse is asymmetrical.

Figure 16 illustrates the laser output given the asymmetric driver pulse of Figure 15. The eye 1600 is symmetrical and not closed. Figure 17 illustrates the chirp resulting form the driver pulse of Figure 15. The chirp is reduced when compared to the chirp in Figure 4. In Figure 17, the peak-to-peak value is less than 13 units. Thus, the receiver sensitivity is not degraded and ringing is avoided.

Pulse Propagation Over Single Mode Optical Fiber

Figure 18 illustrates pulse propagation over single mode optical fiber in accordance with one embodiment of the present application. The transmission speed is 10 Gbit/s. In pane 1 1800, an asymmetrical pulse is generated. Each pulse has a pulseshape with a linear slope for both the rising and falling edge. The fall time is 20 ps, and the rise time is 60 ps. The pulses are sent to a transmitter and the resulting signal is in pane 2 1810. The signal has a reduced overshoot when compared to the signal in pane 2 of Figure 7B.